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PRELIMINARY ASSESSMENT OF GEOTHERMAL POTENTIAL

NEVADA TEST SITE
NYE COUNTY, NEVADA

Prepared for:

UNITED STATES DEPARTMENT OF ENERGY

Prepared by:

DIVISION OF EARTH SCIENCES
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EXECUTIVE SUMMARY

This preliminary assessment suggests that there is potential for geothermal resource development on the Nevada Test Site (NTS) that could support, among others, the proposed solar energy technology development project (Solar Enterprise Zone). Geothermal exploitation of the NTS can also provide an opportunity to explore new geothermal technology for exportation to other locations. This report is preliminary, however, and further in-depth analysis is necessary before an adequate evaluation of geothermal potential on the NTS is performed and before decisions to develop NTS geothermal resources can be made.

Location, depth, temperature, and fluid geochemistry data were collected for existing wells and springs from the Nevada Test Site and surrounding area. Temperature gradients calculated from these data range from 25°C/km to 45°C/km, comparable with gradients in northern Nevada where economic geothermal development is widespread. Silica chemical geothermometers calculated from selected wells and springs range widely from 16°C to 147°C. Alkali geothermometers range from 135°C to 290°C. These temperature estimates compare with a maximum measured subsurface temperature of 121°C. Geohydrologic studies of selected aquifers indicate that fluid flow occurs largely in faults and fractures associated with principal fault zones.

Taken together, these data suggest there is a potential for discovering geothermal fluids at drillable depths, and at sufficiently high temperatures and flow rates, to support the generation of electricity from geothermal energy. A complete assessment of geothermal potential at the NTS requires the incorporation of additional data sets, including geologic and geophysical information, geothermal technology options, and an economic analysis of geothermal implementation options at the NTS. These issues are outlined in the recommendations.

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INTRODUCTION

The U.S. Department of Energy (DOE) Strategic Plan and DOE/NV Strategic Plan focus on encouraging energy efficiency and advancing alternative and renewable energy technologies in order to provide choices to energy users, reduce dependency on imported oil, and provide adequate, clean energy supplies. The DOE Strategic Plan stresses a desire for the U.S. to be a world leader in the development, application, and export of sustainable, environmentally attractive and economically competitive energy systems by the year 2010. Geothermal energy is one of these sustainable, environmentally attractive, and economically competitive energy resources wherever geothermal resources are indicated.

An example of applying geothermal technology on the NTS is the proposed Solar Enterprise Zone. Prohibitive costs for running a natural gas line or upgrading the existing power line to the proposed site in Area 25 (Jackass Flats) may preclude the project at an early stage of consideration. However, if geothermal resources are found to be adequate for generating electricity using current technology, the solar enterprise zone could be coupled with geothermal energy, which would be the source for inlet steam or reheaters for the parabolic trough thermal systems.

A geothermal plant or a series of small geothermal plants could also provide independent power to the NTS for other future projects. In addition, lower temperature geothermal resources could be applied to numerous innovative new applications, providing new uses for the NTS while generating new technology for exportation to other sites in the U.S. and other parts of the world. In other words, exploration and development of geothermal resources on the NTS is consistent with goals set in both the DOE and DOE/NV Strategic Plans and should be pursued.

Although there are dozens of test holes, wells, and shafts throughout the area, the NTS has never been systematically explored for geothermal resources. Geologic and hydrologic investigations at the NTS have focused on two areas of interest. Historically, the principal focus was the delineation of subsurface formations suitable for the underground detonation of large nuclear devices. A secondary focus is the identification of underground aquifers suitable for the development of potable water sources.

This report is an evaluation of existing subsurface temperature data from water wells, test wells, and emplacement wells on the NTS. In addition, temperature information from off-site agricultural water wells (principally in the Amargosa Desert), municipal and private wells, test wells associated with Yucca Mountain Studies, and natural springs is included. One of the limits of this study, it should be noted, is that none of the wells were sited or drilled for the purposes of exploring for or developing geothermal energy resources. In spite of that, the data suggest that properly sited, drilled, and completed test wells have the potential to delineate geothermal resources at the NTS.

GEOTHERMAL DEVELOPMENT IN NEVADA

Nevada is the second largest producer of geothermal electricity in the United States; on a per capita basis, it ranks number one. At present, the State produces approximately 210 Megawatts (MWe) from 11 geothermal power plants (Figure 1). This is enough electricity to support approximately 210,000 households. Most of this development has taken place since 1984 (Figure 2) and is the direct result of efforts of the United States Department of Energy's Geothermal Technology Program which focused a comprehensive exploration program in the northern Basin and Range from 1978 through 1983. This industry-coupled program featured reasonably successful drilling, and capitalized on technological achievements and economic innovations. One noteworthy milestone was the application of Rankine cycle technology to moderate-temperature resources, resulting in the widespread development of binary geothermal power plants.

In 1980, geothermal resources with temperatures less than 204°C (400°F) were considered uneconomical for electric power generation. Today, commercial power plants using binary technology can operate at 98°C (208°F). In binary power plants, heat is transferred from the geothermal fluid to a hydrocarbon "working fluid," such as butane or iso-pentane, which vaporize at lower temperatures than water. Required flow rates of geothermal fluids vary as a function of temperature. At 120°C (250°F), for example, 55 liters per second (lps; 850 gpm) are required to produce one MWe; at 176°C (350°F), only 16 lps (250 gpm) are required. Many binary plants are air-cooled, and all binary plants inject produced fluids back into the geothermal reservoir. This technology has greatly increased the geothermal resource base and has accelerated development in the United States and other parts of the world. Plants range in size from 1 to 20 MWe, and the produced power is compatible as base load to electric power grids.

GEOTHERMAL POTENTIAL ON THE NTS

Additional, reliable electric power will play a key role in plans to diversify the mission of the NTS. Existing facilities and programs at the NTS (Figure 3) utilize approximately 40 MWe annually, and the power transmission line to the NTS is close to capacity. Potential uses will impose an even greater demand. Figure 3 includes the proposed Solar Enterprise Zone in Area 25.

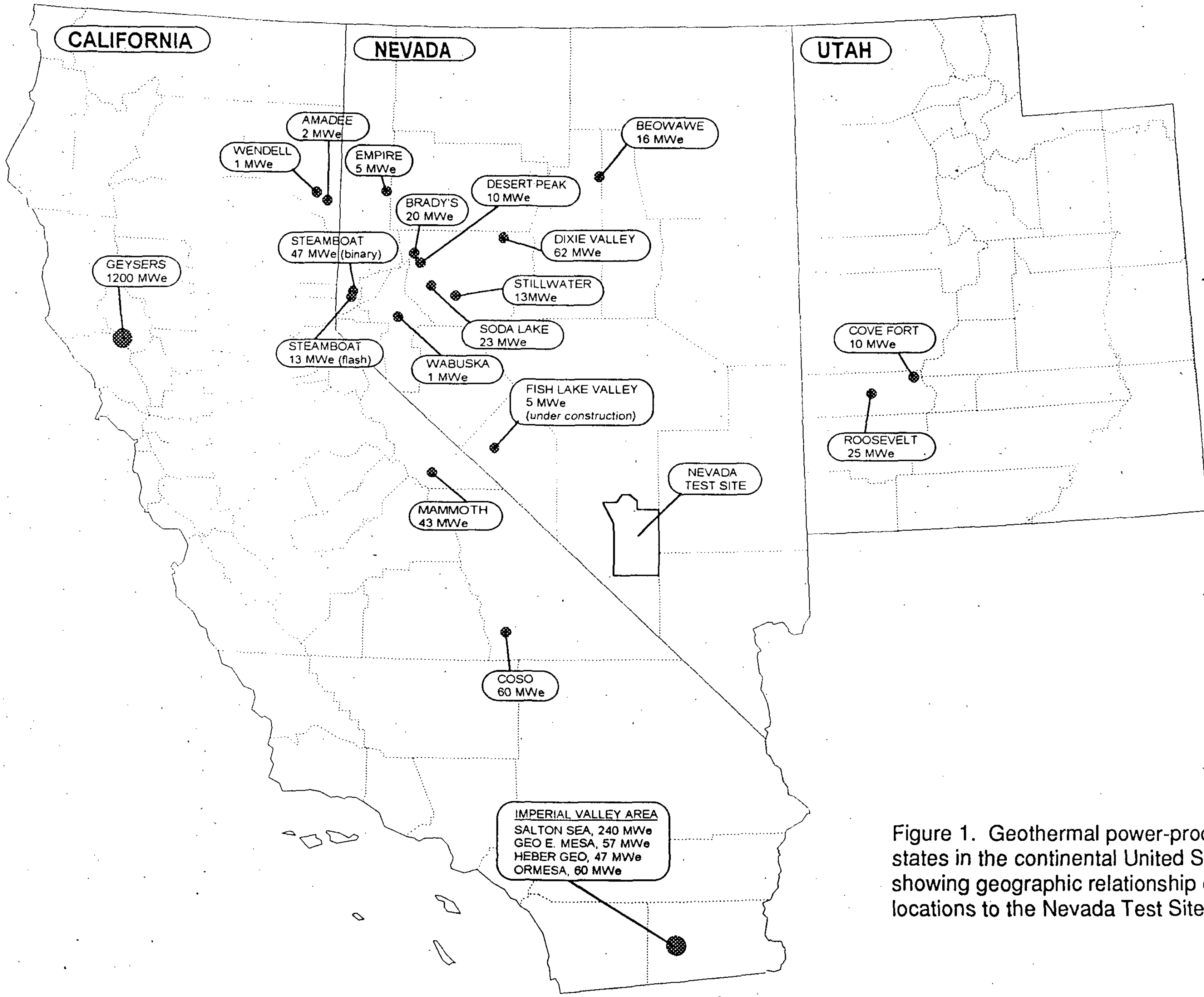

Figure 1. Geothermal power-producing states in the continental United States, showing geographic relationship of the locations to the Nevada Test Site.

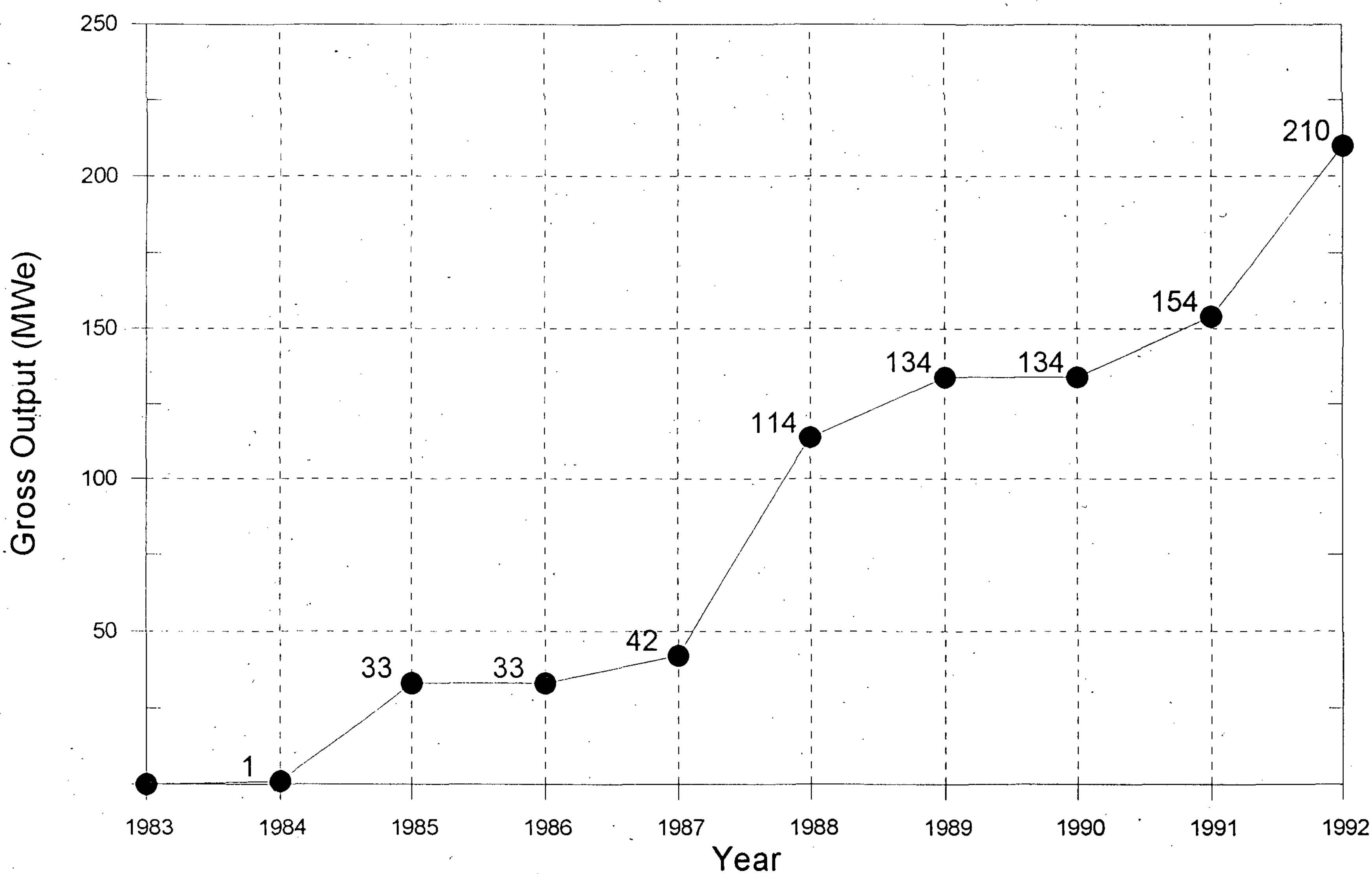

Figure 2. Year-by-year increase in output of geothermal plants in Nevada since the first plant went on-line in December 1984

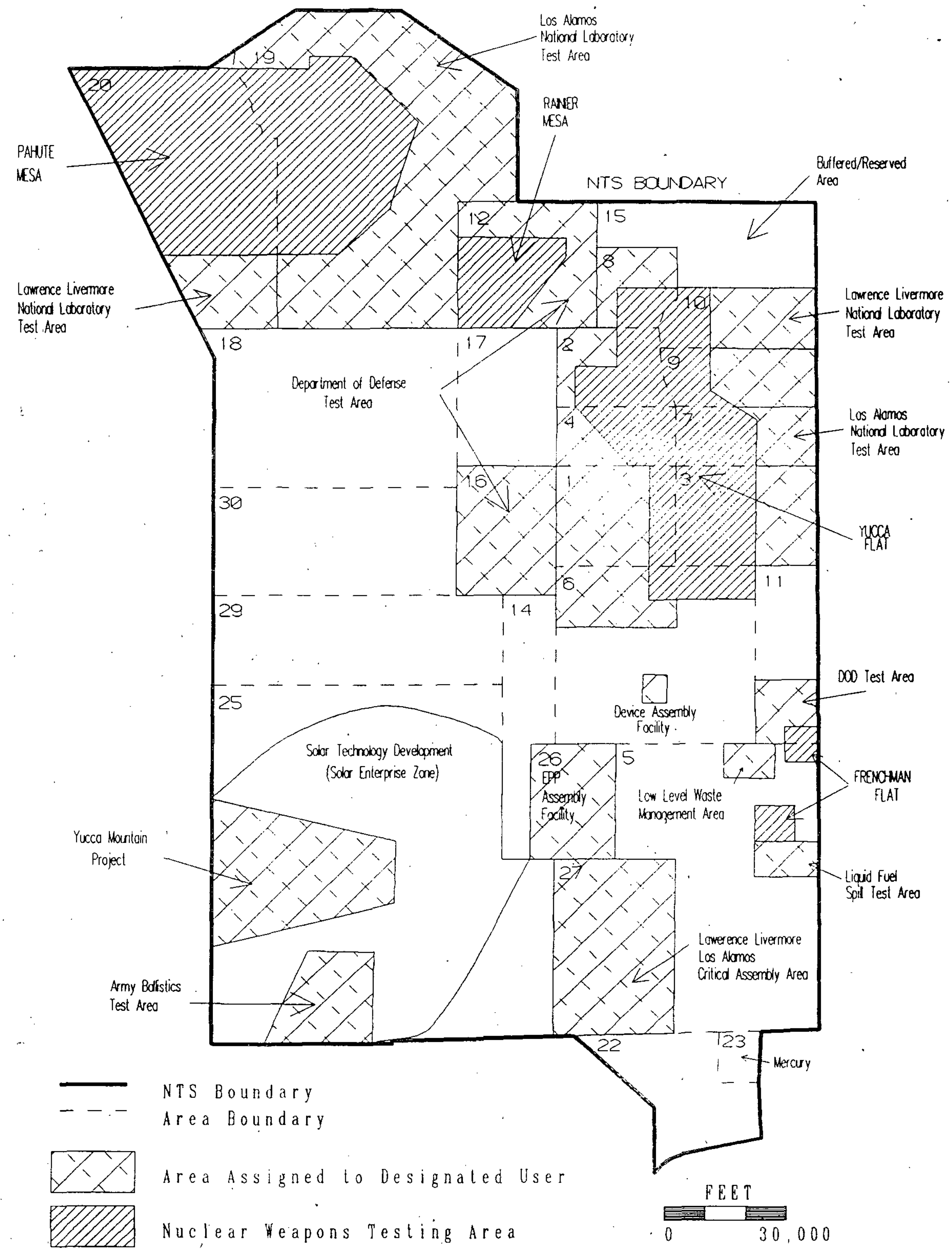

Figure 3. Existing and potential uses of the Nevada Test Site

as a potential new use for the NTS. Clean, environmentally benign, economical, renewable energy resources must be developed to provide that power. Among the practical options, geothermal energy ranks at the top. As a resource and reserve, it is widespread throughout Nevada and many other western states, it is a proven technology in Nevada, California, Utah, and Hawaii, is available full time, and can be developed economically in appropriately sized power plant modules as needed. Geothermal power has already been successfully integrated into electrical utility resource plans and grids throughout the world.

The economic exploitation of geothermal resources depends on the co-location of three critical factors: a heat source of sufficient magnitude; a source of fluids in sufficient volume; and an extensive, deep fracture system that allows fluids to flow from the surface, to the heat source, and back to the surface. This report evaluates the existing subsurface temperature data at the NTS. This is the first step in the determination if these three factors are present at the NTS and if a more detailed evaluation of the geothermal potential is warranted. Plate 1 (pocket) shows the outline of the NTS and the limits of the study boundary area. The extent of the study area was arbitrarily enlarged to study the relationships between on-site and off-site thermal anomalies.

PREVIOUS STUDIES

Blankennagel and Weir (1973) provide a comprehensive analysis of the geology and hydrology of Pahute Mesa (areas 19 and 20 on Figure 3), and include a brief discussion of the temperature gradient effects on standing water levels. Their findings revealed that fluid flow is largely restricted to fractures and fault zones in the volcanic rocks. Sass and Lachenbruch (1982) completed temperature-depth measurements in 60 wells throughout the test site and concluded that "the steady-state conductive thermal regime has been altered significantly to depths as great as 2 to 3 km" by vertical water movement. Two of the three requirements for a geothermal resource (water and fracture flow) are satisfied by this observation. A subsequent study of data from Yucca Mountain (Sass and others, 1988) arrived at a similar conclusion and suggested a "reconfiguration" of selected test well casings to preclude the possibility of hydrologic disturbances in wells and ensure an unambiguous interpretation of the thermal data collected.

To date, subsurface thermal data suggest that low-temperature geothermal fluids are widespread throughout the study area. Analysis of the deepest wells at the NTS shows, however, that all were drilled at considerable distances from known fault zones. In northern Nevada, fault zones are the principal reservoirs for geothermal fluids. On the basis of geological similarities, the same should be true in southern Nevada.

FINDINGS

Two data sets were used in this preliminary assessment; temperature-depth data from existing wells, and chemical geothermometers calculated from existing chemical analyses of selected natural waters.

Appendix 1 lists the location, designation, depth and temperatures of the wells and springs used in this report. On the NTS, temperature, depth, and location data were acquired for wells in areas 3, 17, 18, 19, 20, 25, 27, and 29. Temperature-depth data were also available from exploration wells drilled in conjunction with site characterization activities at Yucca Mountain.

Temperature gradient data from many wells were not available. To evaluate the regional gradient, composite temperature-depth data were derived by plotting available temperature data against depth of measurement. Figure 4 shows composite temperature gradient data from areas 17, 18, 19, and 20 in the northwest corner of the NTS. The data show gradients in excess of 30°C/km. Figure 5 shows a composite gradient for wells in areas 25, 27, and 29, located in the southwest corner of the NTS. Here, the average gradient approaches 40°C/km, typical of wells in northern Nevada. It should be noted that the maximum depth shown in Figure 5 is 1,500 m, vs. a maximum depth of 3,883 m in Figure 4. Data from the Yucca Mountain area, plotted in a similar manner in Figure 6, also show relatively elevated gradients at shallow depths. Figure 7 illustrates the composite gradient for all the wells described and suggests an average gradient slightly more than 30°C/km. A different, and perhaps more realistic perspective is derived by adjusting the wellhead elevation to a common datum, sea level, and plotting the elevation of the measured interval. Figure 8 shows the results of this adjustment, which changes the average gradient from 29.3°C/km to 31.4°C/km.

Temperature-depth data from two areas immediately north of the NTS, Railroad Valley (Figure 9) and Hot Creek Valley (Figure 10) show that elevated geothermal gradients are not restricted to the northern Basin and Range Province. If geologic structures similar to these areas can be identified at the NTS, then the depth to resource could be considerably reduced.

Temperature estimates shown in Figures 4 through 8 compare favorably with the gradient data. Chemical geothermometers for selected thermal and non-thermal springs and wells were calculated and listed in Table 1.

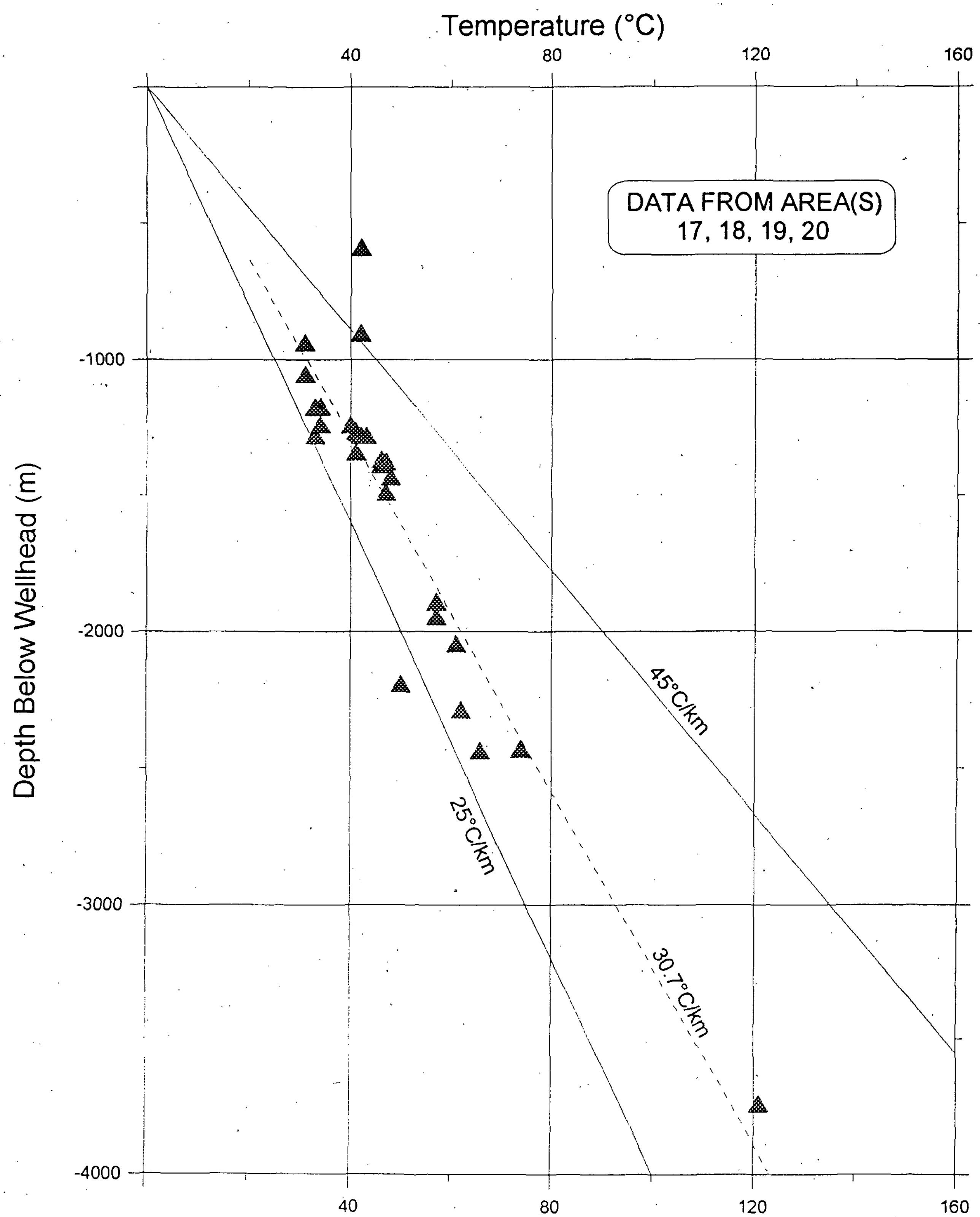

Figure 4. Temperature vs. depth profile for Areas 17, 18, 19, and 20

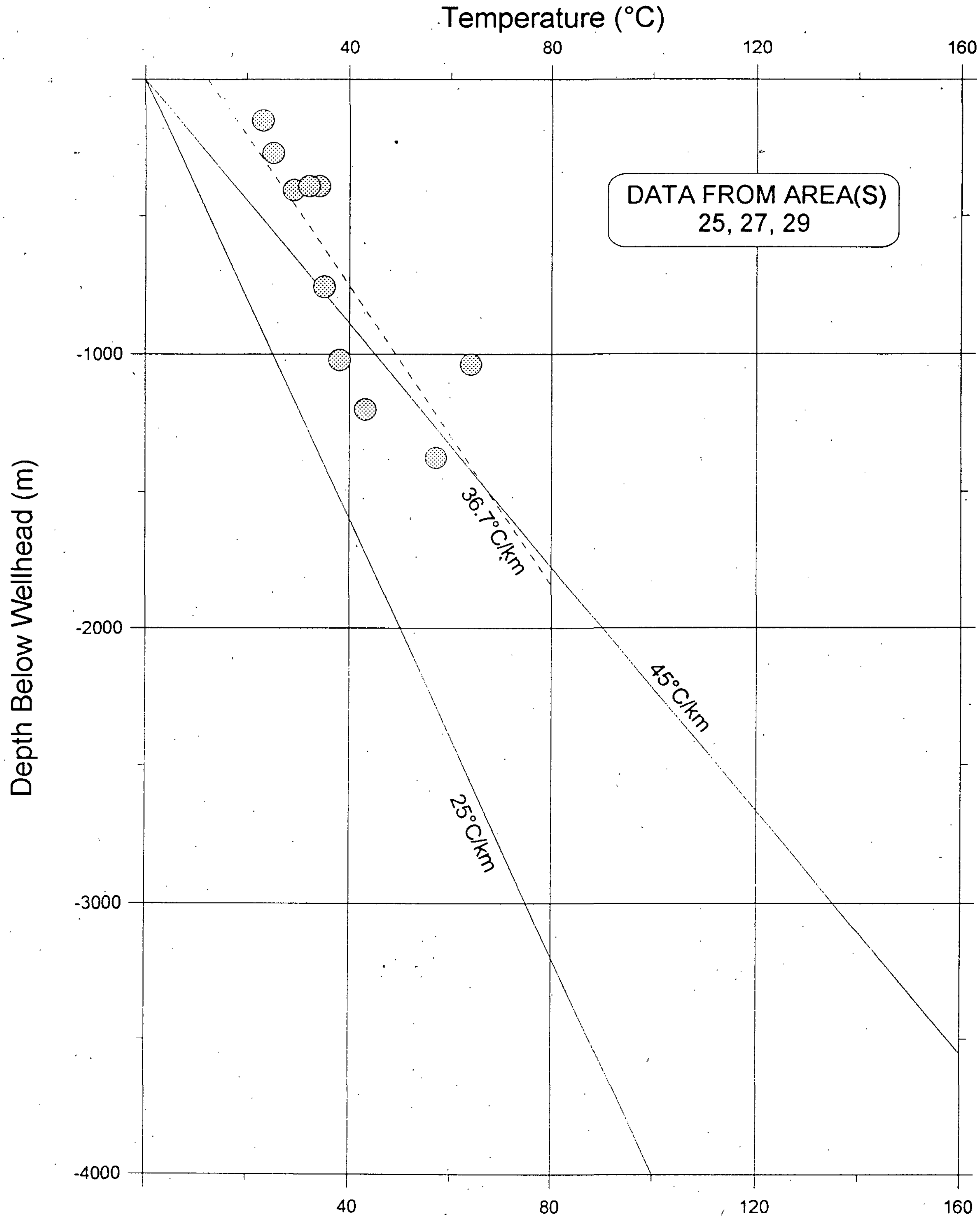

Figure 5. Temperature vs. depth profile for Areas 25, 27, and 29

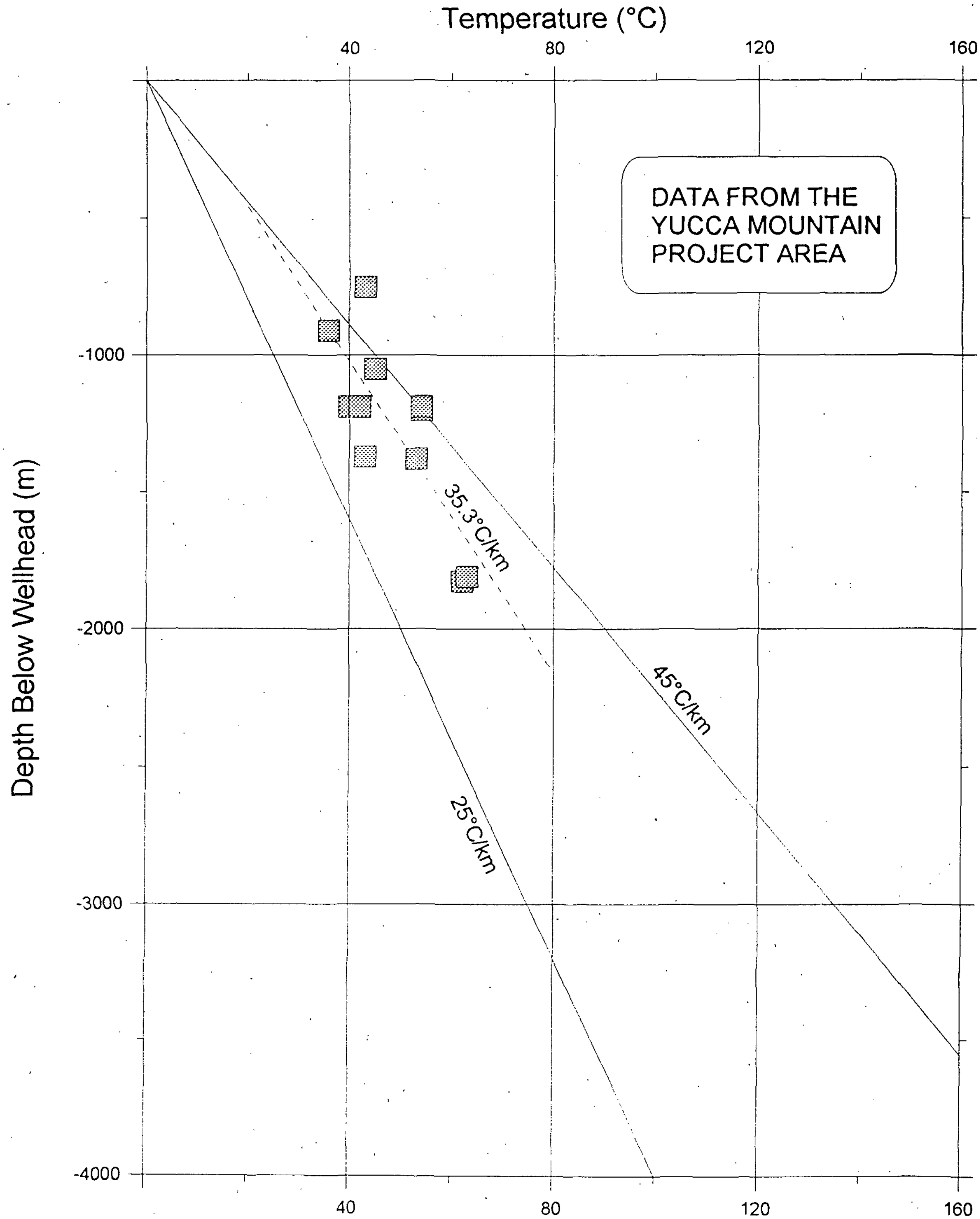

Figure 6. Temperature vs. depth profile for the Yucca Mountain area

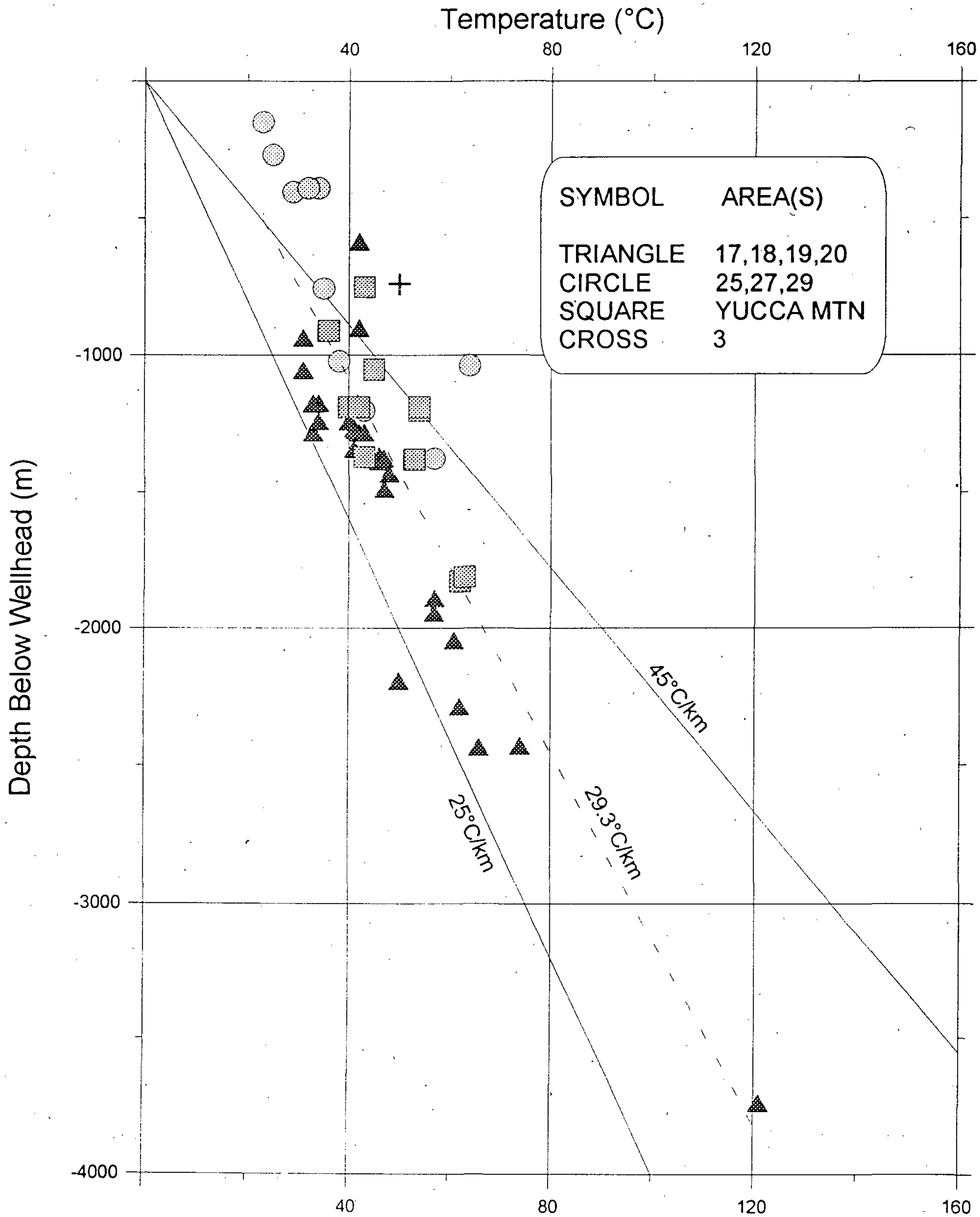

Figure 7. Temperature vs. depth profile for all data used in Figures 4, 5, and 6, along with one additional point from Area 3

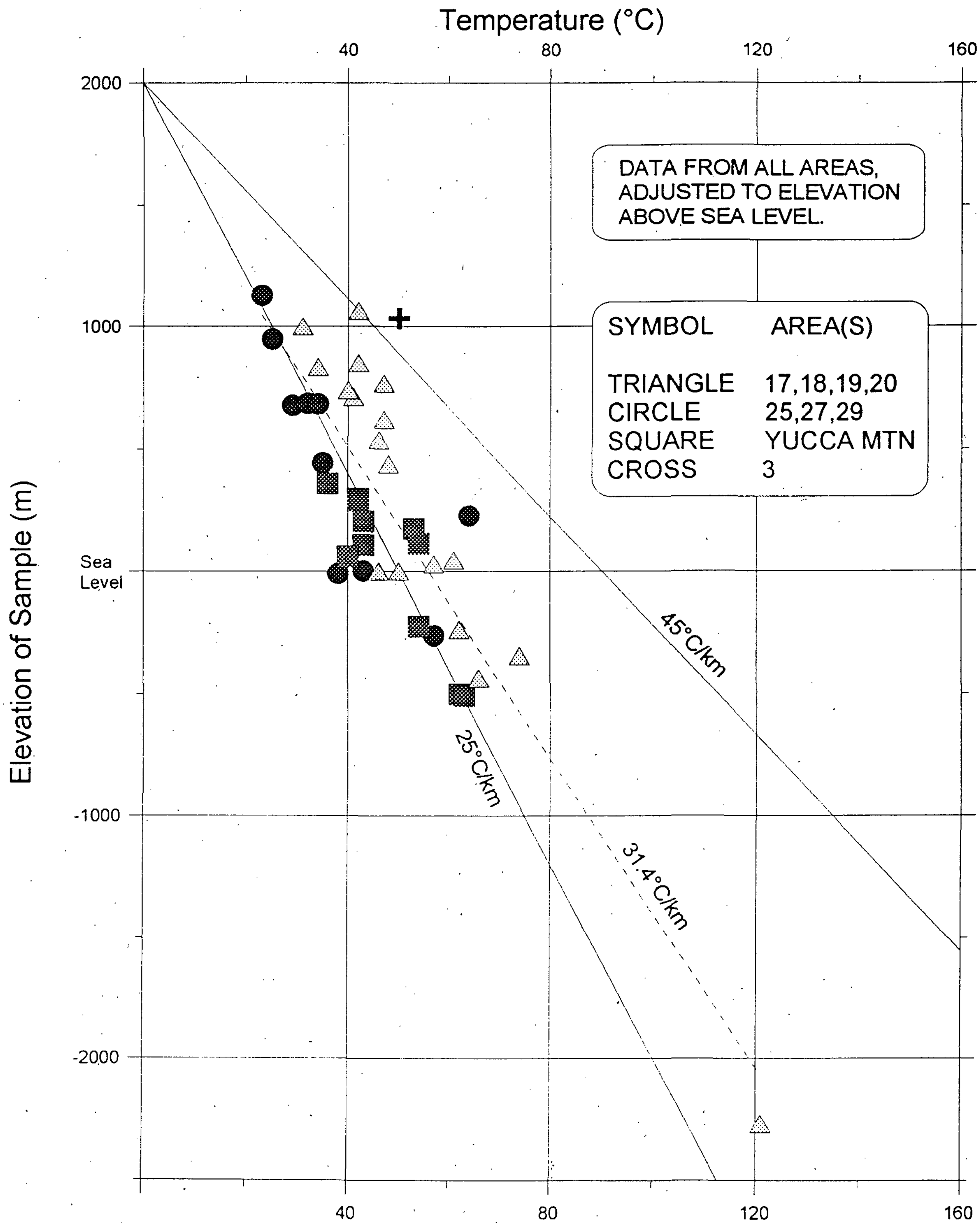

Figure 8. Temperature vs. depth profile with the same data used in Figure 7; sample depths are plotted as actual elevation above sea level to normalize depths and account for differing well-head elevations.

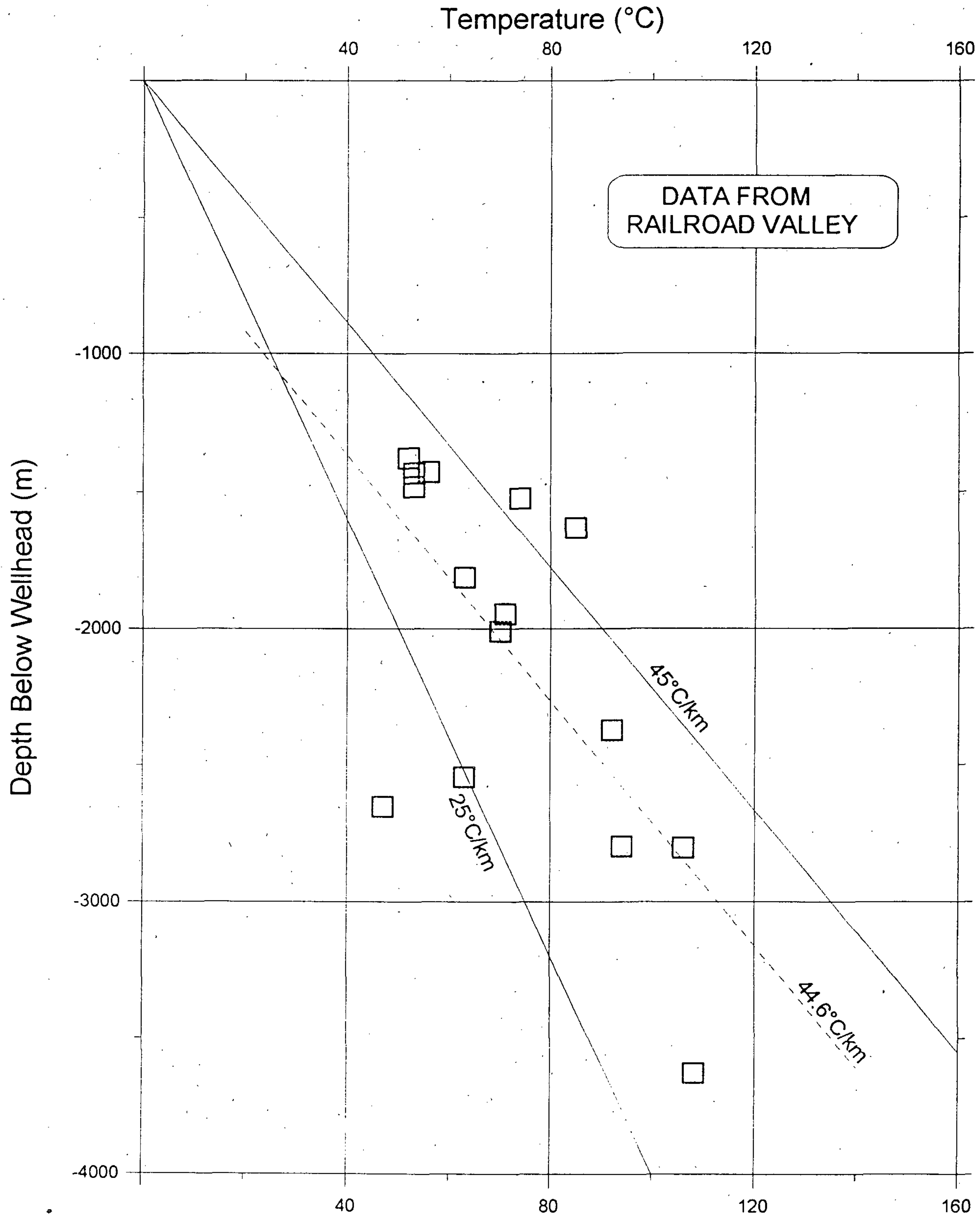

Figure 9. Temperature vs. depth profile for data from Railroad Valley

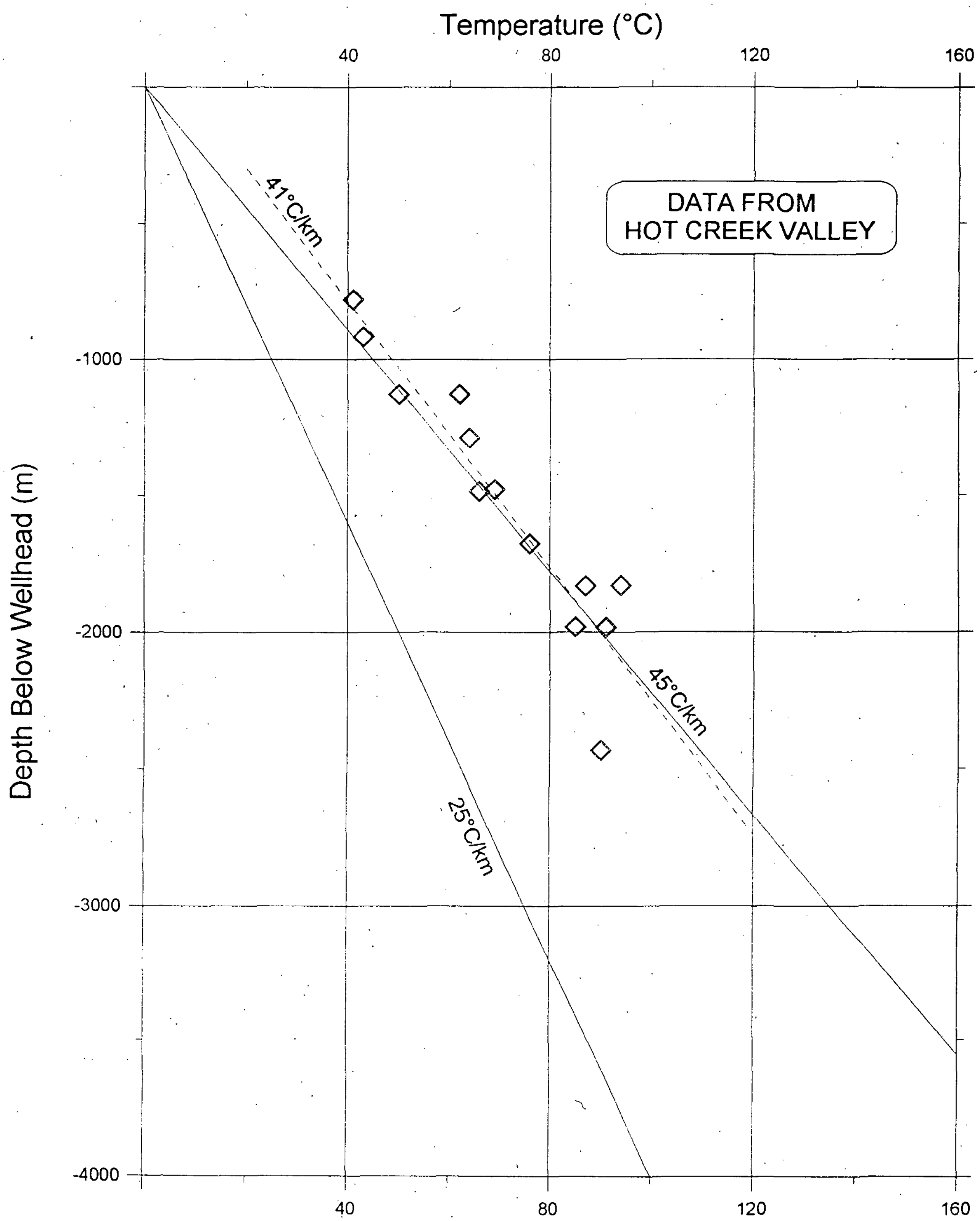

Figure 10. Temperature vs. depth profile for data from Hot Creek Valley

Table 1. Chemical Geothermometers Calculated for Selected Sites.

Site Name	T°C	Quartz NSL	Quartz MSL	Chalcedony	NA/K (Four.)
Test Well E	42	111	110	82	135
Well J-11	32	115	114	87	218
Ash Tree Spring	18	125	122	97	259
Devil's Hole	27	65	70	33	233
Test Well F	64	89	91	58	255
Whiterock Spring	8	147	141	121	290

NSL = no steam loss; MSL = maximum steam loss; Four. = Fournier, 1981.

PRELIMINARY TECHNOLOGY AND ECONOMIC ANALYSIS

The results of this study suggest the possibility of discovering geothermal fluids consistent with temperatures required for binary electric geothermal power production as listed in Table 2.

Table 2. Operating Binary Geothermal Power Plant Specifications.

Plant Name, State	Wellhead Temp. (°C)	Flow (lps)	Gross MWe	Net MWe
Wabuska, Nevada	103	8	1.2	0.85
Amedee, California	98	5	3.0	1.70
Wendell, California	109	4	0.8	0.50

CONCLUSIONS

The number of geothermal power-producing options available at the NTS is a function of temperature, depth, and flow rate of the resource. This study suggests that there is a very good potential for the discovery of a moderate temperature geothermal resource capable of supporting a binary geothermal power plant. The ultimate configuration will be determined as more reliable data become available through further test hole drilling. Hybrid configurations, involving the generation of electric power in conjunction with direct use projects and solar energy projects are consistent with the intent of the Energy Policy Act of 1992 and greatly increase the probability of successfully integrating renewable energy resources into the mission of the NTS.

RECOMMENDATIONS

The next logical step is a comprehensive technical and economic feasibility study of geothermal potential at the NTS. As described above, the options available depend largely on the nature of the resource. We recommend a 12- to 18-month investigation entitled Nevada Test Site Geothermal Development Potential that would focus on geothermal resources and reserves, technology options, economics of development, and the socioeconomic impacts on NTS facilities, infrastructure, and human resources. The study's focus would be in areas for which new uses are proposed (e.g., the Solar Enterprise Zone site in Area 25) and would avoid sensitive areas and those contaminated by previous DOE/NV missions.

The proposed scope of work includes collection of geological, geochemical, geophysical, remote sensing, and drilling survey data, followed by plotting of data using in-house GIS capabilities. Data interpretation would be performed and recommendations offered based on findings. Interpretation would focus on sources of heat and fluids, fracture systems, and locations of existing surface and subsurface facilities.

In the Great Basin physiographic province, presently operating geothermal power plants include: single flash; dual flash; binary; and hybrid power plants. Experimental power plants include Hot Dry Rock (HDR); Kalina Cycle; and geopressured power plants. Each of these plants will be described and compared to the anticipated resources available at the NTS.

Direct utilization technologies are those that use the thermal energy with no conversion to electricity. There are many examples in Nevada and other western states including: industrial process heating, such as food dehydration and enhanced cyanide heap leaching; commercial and residential space heating; aquaculture (fish rearing); agriculture (greenhouse); and cascading, which capitalizes on high and low temperatures from the same resource.

Once the technological options have been fully explored, an economic analysis of geothermal implementation at NTS should be completed. This would include an investigation of possible project configurations; existing market conditions; economic models; comparative economic evaluations of options; flash and dual flash options; binary options; binary-solar-hybrid options; binary-direct utilization options; and experimental configurations.

The economic analysis would address the employment and socioeconomic impacts of geothermal development at the NTS. The critical aspect of this section is to estimate the effects of geothermal development on the mission of the NTS. The economic analysis would also address power requirements and plant output; direct use requirements; hybrid systems; and experimental systems.

Electric power generated from geothermal resources is already economic and competitive. On the basis of the preliminary assessment, low-temperature fluids on the NTS may be suitable for electric power conversion with conventional binary, hybrid binary, or experimental configurations. Such development can be integrated into the NTS missions and efforts to develop geothermal resources will benefit from the human resources, equipment, and expertise available on the NTS.

APPENDIX 1

NTS WELL AND SPRING TEMPERATURE DATA

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)
NTS AREAS 1 THROUGH 6											
684073	833046	USGS A	MAT	A01	WELL	1221	27	3	71		570
669775	879921	Test Well 2	BOU	A02	WELL	1362	35	6	82		
690741	839645	Test Well E	973	A03	WELL		50			740	740
684297	843242	Test Hole 7	MAT	A03	WELL	693	21	2	58		693
672606	846443	USGS D	MAT	A04	WELL	1265	26	1	60		594
707228	741462	Well 5C	BOU	A05	WELL	939	26	6	82		
704257	747265	Well 5B	MAT	A05	WELL	943	27	9	57		274
707545	738188	Well 5A	MAT	A05	WELL	943	24	4	58		277
668254	745570	Cane Spring	MAT	A05	SPRG	1286	19	9	57		
690791	789766	Well C	BOU	A06	WELL	1104	37	6	82		
685838	787184	Well 4	BOU	A06	WELL	1097	28	6	82		
677750	817714	Well 3	MAT	A06	WELL	1210	23	3	58		548
694675	819648	Butte Spring	MAT	A06	SPRG	1582	11	11	67		
NTS AREAS 12 THROUGH 18											
637390	888115	Rainier Spring	MAT	A12	SPRG	1902	16	9	57		
646447	883065	Captain Jack Spring	MAT	A12	SPRG	1673	13	5	59		
682203	895292	UE15d	BOU	A15	WELL	1398	30	6	82		
624482	908442	Oak Spring	MAT	A15	SPRG	1768	13	4	58		
674290	903251	Marble 3	MAT	A15	WELL	1620	22	7	59		298
648758	832470	UE16f	MAT	A16	WELL	1957	23	9	77		394
646648	845202	UE16d	BOU	A16	WELL	1428	25	6	82		
636485	835320	Tippipah Spring	MAT	A16	SPRG	1597	12	3	58		
645000	865000	UE17e	973	A17	WELL		42			900	900
602000	879500	UE18t	973	A18	WELL		42				585
564906	868190	UE18r	MAT	A18	WELL	1662	32	1	68		1525
610041	879983	Well 8	BOU	A19	WELL	1750	27	6	82		
NTS AREAS 19 AND 20											
593041	909774	UE19i	712	A19	WELL	2085	74	9	65	2429	2438
586500	946404	UE19h	712	A19	WELL		31	7	65	1053	1129
587732	931602	UE19gs	712	A19	WELL	2048	62	5	65	2286	2286
586957	900653	UE19fs	712	A19	WELL	2053	41	8	65	1341	2118
596784	921438	UE19e	MAT	A19	WELL	2109	47	8	64	1487	1830
600186	945843	UE19d	712	A19	WELL	2091	61	6	64	2045	2343
601164	917085	UE19c	MAT	A19	WELL	2144	47	3	66	1375	2587
606337	933852	UE19b-1	MAT	A19	WELL	2073	34	6	64	1238	1371
601747	916723	U19c	BOU	A19	WELL	2143	47	6	82		
		UZ20c#1	RSN	A20	WELL		57			1942	
38587	928212	UE20j	712	A20	WELL	1387	46	10	64	1387	1734
567698	918074	UE20h	712	A20	WELL	2193	50	8	64	2193	2197
551986	918040	UE20f	712	A20	WELL	4171	121	6	64	3740	4171
560970	934442	UE20e-1	712	A20	WELL	1919	57	5	64	1889	1949
554331	909307	UE20d,b	712	A20	WELL	1906	46	8	64	1368	1630
574286	931602	U20g#1	RSN	A20	WELL		40	6	86	1241	

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)
NTS AREAS 19 AND 20, continued											
557500	904000	U20C#1	RSN	A20	WELL		48			1432	
571508	907526	U20a-2	MAT	A20	WELL	1973	27	10	64		1371
528970	944404	PM-2	712	A20	WELL	1703	84	8	64		
577580	922105	PM-1	712	A20	WELL	1999	66	5	64	2434	
NTS AREA 22											
685134	672136	Well 1, Army	BOU	A22	WELL	961	32	6	82		
681041	669562	Unnamed Well	BOU	A22	WELL		32	7	62		
NTS AREAS 25 THROUGH 29											
579821	749182	Well J13	649	A25	WELL	1011	38	7	63	1020	1063
581038	733532	Well J12	BSN	A25	WELL	954	27	3	71		347
611764	740919	Well J-11	MAT	A25	WELL	1050	36	12	58		405
571771	691642	Well 69-57	GAR	A25	WELL		28				
571609	755349	UE25p1	649	A25	WELL	1114	57	10	83	1375	1805
569848	757165	UE25c#1	MAT	A25	WELL	1130	42	9	83		914
566317	765165	UE25b1h	649	A25	WELL	1200	43	1	82	1200	1220
565437	766255	UE25a7	649	A25	WELL	1219	25	3	81	270	305
554608	768052	UE25a4	649	A25	WELL	1277	23	10	80	150	152
566318	764801	UE25a1	649	A25	WELL	1199	35	10	80	755	762
579480	766292	UE25 WT#15	649	A25	WELL	1083	29	6	84	405	415
574520	761181	UE25 WT#14	649	A25	WELL	1076	32	6	84	390	399
566084	740046	UE25 WT#12	649	A25	WELL	1074	34	6	84	390	399
661307	731695	Test Well F	MAT	A27	WELL	163	64	3	80	1036	1036
588746	796536	UE29a#2	BSN	A29	WELL	1215	25	1	82		422
616220	795909	Topopah Spring	MAT	A29	SPRG	1768	21	9	57		
AMARGOSA DESERT AREA											
627691	651068	USGS Tracer Well 2	BOU	AMA	WELL		31	2	68		
558631	662489	Unnamed Well	GAR	AMA	WELL		24	8	62		
546034	644264	Unnamed Well	GAR	AMA	WELL		24	2	56		
569539	645041	Unnamed Well	GAR	AMA	WELL		24	8	62		
545168	634434	Unnamed Well	GAR	AMA	WELL		25	12	72		
579112	689114	Unnamed Well	GAR	AMA	WELL		24	6	59		
536618	654443	Unnamed Well	GAR	AMA	WELL		24	8	62		
583771	601760	Unnamed Spring	GAR	AMA	SPRG		32	10	64		
453724	616235	Travertine Spring	WNF	AMA	SPRG	122	34	3	70		
450204	621701	Texas Spring	WNF	AMA	SPRG	122	33	3	70		
597786	633839	Soda Spring	GAR	AMA	SPRG		23	11	66		
601028	631302	Unnamed Well	GAR	AMA	WELL		21	10	70		
606950	620039	Unnamed Well	GAR	AMA	WELL		33	10	70		
614663	603688	Unnamed Well	GAR	AMA	WELL		30	10	70		
617615	601516	Unnamed Well	GAR	AMA	WELL		29	10	70		
619675	601525	Unnamed Spring	GAR	AMA	SPRG		21	3	72		
616146	600782	Unnamed Well	GAR	AMA	WELL		28	10	70		

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)

AMARGOSA DESERT AREA, continued

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)
605212	613116	Scrugggs Spring	GAR	AMA	SPRG	709	30	2	72		
600150	630207	Rogers Spring	GAR	AMA	SPRG	695	29	10	71		
688153	570952	Pahrump Valley Area	GAR	AMA	WELL		23				
509871	705750	Nuclear Eng Co Well	WNF	AMA	WELL	786	29	8	68		
572505	634491	Mecca Well	GAR	AMA	WELL		22	2	71		
603998	623304	Main Spring	GAR	AMA	SPRG		33	10	70		
600168	625111	Longstreet Spring	GAR	AMA	SPRG	702	28	11	66		
616166	596050	Jack Rabbit Spring	GAR	AMA	SPRG		28	11	66		
484094	747981	Hicks (Bailey) Hot Sp	GFG	AMA	SPRG	1097	40	2	89		
596316	633834	Fairbanks Spring	WNP	AMA	SPRG	695	27	5	73		
593176	605430	Embry Well	GAR	AMA	WELL		21	12	71		
613164	610599	D.H. Well	GAR	AMA	WELL		33	3	67		
611399	610592	Devil's Hole	MAT	AMA	SPRG		33	12	66		
604952	603651	Davis Ranch Spring	GAR	AMA	SPRG		21	12	71		
601110	608369	Crystal Pool	WNP	AMA	SPRG	694	31	5	73		
482922	746162	Burrell Hot Springs	GAR	AMA	SPRG		39	2	74		
616786	588408	Bole Spring	GAR	AMA	SPRG		22	7	62		
615890	591316	Big Spring	GAR	AMA	SPRG	683	28	10	76		
476517	789124	Beatty Municipal Spr	GAR	AMA	SPRG		24	2	56		
575212	611201	Ash Tree Spring	MAT	AMA	SPRG	690	18	3	74		
569919	728769	Amargosa Desert	GAR	AMA	WELL		26	4	58		
694675	819648	AM 101 Amargosa	MAT	AMA	WELL	786	42	3	73		
558698	630455	17S 49E 8DDB - 18	CLA	AMA	WELL	695	24	3	74		
567094	684714	16S 50E 7BCD - 27	CLA	AMA	WELL		31	4	71		
564795	663959	16S 49E 9DCC - 8	CLA	AMA	WELL	735	23	3	74		
556189	709445	16S 49E 8ABB - 5	CLA	AMA	WELL	735	23	11	72		
552481	653740	16S 49E 19DAA - 11	CLA	AMA	WELL	720	26	3	74		
565969	663962	16S 49E 15AAA - 29	CLA	AMA	WELL		24	3	71		
516333	684639	16S 48E 7CBC - 47	CLA	AMA	WELL		24	3	71		
546317	650817	16S 48E 25AA - 13	CLA	AMA	WELL	710	27	3	74		
535435	660994	16S 48E 15AAA - 23	CLA	AMA	WELL	720	26	3	71		
531026	664994	16S 48E 10CBA - 25	CLA	AMA	WELL	725	25	3	71		
463463	641338	Nevares Spring	WNF	DVY	SPRG	293	39	3	70		

LAS VEGAS VALLEY

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)
765884	607978	Willow Spring	LYL	LVS	SPRG	1829	11	6	85		
695091	547337	Wilcox Well	GAR	LVS	WELL		26	10	64		
653946	631176	Unnamed Well	GAR	LVS	WELL		28	4	58		
601988	609828	Unnamed Well	GAR	LVS	WELL		32	11	66		
618164	610983	Unnamed Well	GAR	LVS	WELL		26	2	72		
803862	661151	Unnamed Spring	GAR	LVS	SPRG		26	10	64		
797107	661079	Unnamed Spring	GAR	LVS	SPRG		26	12	12		
793027	572566	Stewart Well	LYL	LVS	WELL	2530	10	6	86		
615840	603693	Point of Rocks Spring	WNF	LVS	SPRG	705	32	3	70		
823652	651540	Point B Well	LYL	LVS	WELL	975	25	6	86		
800626	550437	Mt Charleston Lodge	LYL	LVS	WELL	2320	10	8	82		

STATE PLANE COORD EASTING	NORTHING	LOCATION NAME	REF	NTS AREA #		ELEV (M)	TEMP °C	MO	YR	SAMPLE DEPTH (M)	TOTAL DEPTH (M)
LAS VEGAS VALLEY, continued											
793278	662131	Indian Springs	WNF	LVS	SPRG	969	25	3	70		
826972	643932	Indian Spring Prison	LYL	LVS	WELL	1024	23	6	85		
789401	667916	Indian Spring AFB	LYL	LVS	WELL	954	24	6	85		
616738	600056	Indian Seeps	GAR	LVS	SPRG		32	10	64		
617615	601516	Indian Rock Spring	GAR	LVS	SPRG		33	11	70		
816208	554610	Highway Maint. Well	LYL	LVS	WELL	1960	11	9	82		
806327	568701	Deer Creek Spring #2	LYL	LVS	SPRG	2652	8	6	85		
771485	606938	Cold Creek Spring	WNF	LVS	SPRG	1890	11	3	70		
778584	573149	Clark Spring	LYL	LVS	SPRG	2648	10	6	85		
717552	617760	Big Timber Spring	LYL	LVS	SPRG	2048	11	6	85		
NEAR THE SOUTHEAST CORNER OF THE NTS											
735258	751513	Test Well 3	GAR	SEC	WELL		38	5	62		
738862	671812	Test Well 10	973	SEC	WELL		27	6	64		
SARCOBATUS FLAT AREA											
492610	846999	Sarcobatus Flat Area	GAR	SFB	SPRG		22	3	62		
447148	871077	Sarcobatus Flat Area	GAR	SFB	WELL		42	6	64		
473298	785486	Sarcobatus Flat Area	GAR	SFB	SPRG		26	4	67		
482369	797856	Sarcobatus Flat Area	GAR	SFB	SPRG		31	3	62		
490861	852825	Sarcobatus Flat Area	GAR	SFB	SPRG		22	3	62		
485308	830620	Sarcobatus Flat Area	GAR	SFB	SPRG		24	3	62		
464331	860491	Sarcobatus Flat Area	GAR	SFB	WELL		22	3	62		
YUCCA MOUNTIAN PROJECT											
526250	748717	USW VH2	649	YCM	WELL	974	54	3	84	1200	1219
535624	743267	USW VH1	649	YCM	WELL	954	43	1	81	750	762
555203	763321	USW H6	649	YCM	WELL	1302	54	11	82	1188	1220
559002	765513	USW H5	649	YCM	WELL	1478	42	11	82	1188	1200
563985	761519	USW H4	649	YCM	WELL	1249	40	11	82	1188	1225
558436	756411	USW H3	649	YCM	WELL	1483	42	11	82	1187	1219
562501	770617	USW H1	649	YCM	WELL	1302	63	11	82	1810	1829
564267	766253	USW G4	649	YCM	WELL	1270	36	12	82	910	915
558138	758958	USW G3	649	YCM	WELL	1480	43	11	82	1371	1533
566286	778271	USW G2	649	YCM	WELL	1554	53	9	82	1380	1831
561042	769158	USW G1	649	YCM	WELL	1326	62	9	80	1827	1829

REF	Reference	REF	Reference
649	Sass et al., 1988	LYL	Lyles and Hess, 1988
712	Claassen, 1985	MAT	Matuska, 1989
973	Sass and Lachenbruch, 1982	RSN	Fiore, 1994
BOU	Boughton, 1986	WNF	Winograd and Friedman, 1972
BSN	Benson et al., 1983	WNP	Winograd and Pearson, 1976
GFG	Flynn and Buchanan, 1990		

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